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# Conceptual Models of the Mission Space (CMMS)
# Technical Framework

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## Revision History

| Revision | Date | Author | Description |
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| 0.1.1 | 13 MAR 1996 | Jack Sheehan, et al | initial draft |
| 0.1.2 | 04 APR 1996 | Jack Sheehan, et al | re-focus on CMMS content |
| 0.1.3 | 12 APR 1996 | Jack Sheehan, et al | define common syntax and semantics |
| 0.1.4 | 19 APR 1996 | Jack Sheehan, et al | resolve internal DMSO comments |
| 0.1.5 | 24 APR 1996 | Jack Sheehan, et al | re-arrange sections to change order of presentation to begin with most concrete and end with more abstract concepts, modify interactions, replace transaction with task |
| 0.1.6 | 25 APR 1996 | Jack Sheehan, et al | change direct-object, task, and interaction definitions |
| 0.2.0 | 20 DEC 1996 | Jack Sheehan, et al | include DE process, update EATI, resolve comments from DIA, JSIMS, and JWARS |
| 0.2.1 | 13 FEB 1997 | Jack Sheehan, et al | separate CMMS-TF from DE-TF |

# 1. Introduction

## 1.1 Purpose

This paper specifies the Conceptual Models of the Mission Space Technical Framework (CMMS-TF). Within the DoD Modeling and Simulation Common Technical Framework (DoD M&S CTF) [1], the CMMS Technical Framework provides the:

- technical standards ,
- administrative procedures, and
- operational infrastructure

required for conceptual model integration within simulation projects and interoperability across DoD programs. In particular, the CMMS-TF provides:

- the common semantics and syntax for describing the mission space,
- a closed-loop engineering process for creating and maintaining conceptual models, and
- data interchange standards for conceptual model integration and interoperability.

## 1.2. Applicability

This specification applies to the DMSO sponsored CMMS Technical Framework Toolsets being developed under the DoD Directive 5000.59 Modeling and Simulation Master Plan [1]. The CMMS-TF Version 0.2.1 specifically addresses the military operations mission space. Many of the principles established here are equally valid in other well-defined DoD mission spaces, such as medical care or manufacturing; however, detailed discussion of these other mission spaces are beyond the scope of version 0.2.1.

## 1.3. Organization

This specification of the CMMS Technical Framework is organized as follows. Section 1 introduces the CMMS-TF. Section 2 provides an overview of the fundamental concepts and components of the framework. Section 3 provides CMMS integration and interoperability requirements. Lengthy expositions or extended examples are provides as enclosures. References, figures, and tables are collected in to Sections 4, 5, and 6, respectively. Section 7 provides a compendium of CMMS-TF specifications. Where appropriate, technical derivations or detailed trade-studies are referenced as external documents. Specific CMMS standards which provide formal Interface Design Descriptions (IDD) are referenced as external annexes to this document. Wherever possible, this CMMS Technical Framework specification employs the semantics and syntax of the Data Engineering Technical Framework (DE-TF) [2].

## 1.4. Objectives

The Defense Modeling and Simulation Office (DMSO) is leading the effort to develop the M&S Common Technical Framework (M&S CTF):

- High Level Architecture [3-5]
- Conceptual Models of the Mission Space, and
- Data Standards [2]

as directed in the DoD Modeling & Simulation Master Plan [1]. Within the M&S Common Technical Framework, CMMS is a simulation-independent first abstraction of the real world of activities associated

with a particular set of missions. The initial DoD CMMS development focus will be on the military operations mission space. CMMS will provide rigorous descriptions of military operations for the simulation developer which are independent of any particular simulation implementation. As employed by DoD simulation programs [6-11], CMMS is:

- the disciplined procedure by which the simulation developer is systematically informed about the real world problem to be synthesized,
- the information standard the simulation subject matter expert employs to communicate with and obtains feedback from the military operations subject matter expert,
- the real world, military operations basis for subsequent, simulation-specific analysis, design, and implementation, and eventually verification, validation, and accreditation/certification, and
- a singular means for identifying re-use opportunities in the eventual simulation implementation by establishing commonality in the real world activities.

CMMS is composed of three primary components:

- conceptual models:consistent representations of real world military operations,
- technical framework: standards for knowledge creation and integration,
- common repository: DBMS for registration, storage, management, and release.

The CMMS Technical Framework defined here specifies the technical standards, administrative procedures, and systems infrastructure required to ensure that the CMMS descriptions of military operations provided in the CMMS common repository are:

- derived from authoritative sources,
- described using common semantics and syntax,
- interchanged using standard data formats,
- subject to rigorous quality checks,
- released to authorized consumers,
- protected from unauthorized access or modification, and
- independent of any simulation implementation.

A fundamental objective of CMMS is to provide simulation developers with timely and cost-effective access to accurate mission space conceptual models which are created, authenticated, and maintained by others. For example, it is a CMMS objective to enable the direct use of conceptual models of infantry engagements by WarSim-2000 in the development of close air support conceptual models by NASM for eventual use by software developers to implement joint Air-Land Battle simulations in JSIMS.

Finally, CMMS is the application of systems engineering practice to the "system of developing simulations". A fundamental tenet of systems engineering is:

- partition the system into standalone components with well defined interfaces, and
- components interact/affect/communicate only through these defined interfaces.

This partition into components followed by integration via interfaces enforces a rigorous separation-of-concerns between the components. It is this separation-of-concerns that makes the implementation of individual components tractable and that makes certain highly desirable activities/attributes such as

- concurrent engineering with just-in-time development,

- interoperability and re-use

technically feasible and programmatically realistic. In this context, CMMS is the well-defined-interface which enables a rigorous systems engineering separation-of-concerns between the military operations SME and the simulation development SME.

## 1.5. Specifications

CMMS Technical Framework specifications are captioned:

- Minimum Requirement: mandatory specification considered necessary (but not necessarily sufficient) for CMMS interoperability and re-use.
- Preferred Practice: best practices specification considered sufficient for CMMS interoperability and re-use.
- Technology Extension: optional specification which in not considered mandatory for CMMS interoperability and re-use but which is considered indicative of the technology adoption trend.

## 2. Fundamental Concepts

The CMMS Technical Framework is built on the foundation of the M&S Data Standards Architecture. The exposition provided here explicitly assume that the reader has reviewed and mastered the concepts and specifications in the Data Engineering Technical Framework, version 0.2.

## 2.1 Basic Definitions from DE-TF

Following the DE-TF, the CMMS-TF employs reserved words, first to define basic terms and concepts and then construct more general and complex terms and concepts from the basics:

**RESERVED WORD**

A specific term or concept which is defined and used to specify the CMMS Technical Framework. These terms will be typed in bold small caps.

The definitions provided in the DE-TF version 0.2 are included here as **RESERVED WORDS** by reference. The definitions of **DATA**, **MODEL**, **INFORMATION**, **REPRESENTATION**, **SIMULATION**, **ABSTRACTION**, **RESOURCE**, and **ARCHITECTURE** are repeated here for convenience:

**DATA**

Specification of facts, parameters, values, concepts, or instructions in a formalized manner suitable for communications, interpretation, or processing by humans or by automatic means. This definition of **DATA** is a compatible modification[1,2] of the definitions in [12-14].

"Messages which resolve ambiguity are information. All other messages are noise." [15]. Therefore:

**INFORMATION**

**DATA** in context related to a specific purpose [16].

[1] Replaced "representation" in [13-15] with "delineation" to avoid circular definition of **REPRESENTATION**.
[2] Added "parameters, values" to definition in [13-15].

**MODEL**

A physical, mathematical, or otherwise logical specification of a system, entity, phenomenon, or process. This definition of **MODEL** is a compatible modification of the definitions in [12-13].

**REPRESENTATION**

The combination of a **MODEL**, process, or algorithm and the associated **DATA**, parameters, or values. Traditional implementations sharply separate algorithms and values. Contemporary object-oriented implementations joins **MODEL** and **DATA** as an object.

**SIMULATION**

The implementation of a **REPRESENTATION** over time. This definition is a compatible modification of the definition in [12].

**ABSTRACTION**

A mental facility that permits humans to view real world problems with varying degrees of detail depending on the current context of the problem [17]. **ABSTRACTION** is the real world equivalent of the synthetic world **REPRESENTATION** used in **SIMULATION**.

**RESOURCE**

The entities and expendable which may be used by a process. Resources include **MODELS**, **DATA**, **REPRESENTATIONS**, **SIMULATIONS**, facilities, equipment, systems, software, source code, manpower, computer time, calendar time, funding, etc.

## 2.2 Representation

Reusable solutions are the central objective of the M&S Common Technical Framework. Reusable solutions are feasible precisely when the **REPRESENTATION** in a prior solution is compatible with the requirements of a subsequent solution. The central objective of the Conceptual Models of the Mission Space is to provide reusable **REPRESENTATIONS** of real world military operations which are independent of any particular **SIMULATION** implementation. As discussed in the DE-TF Section 2.2, the choice of representation is a matter of focus. Two important components of this choice are

- the real world focus of the military activities of interest (the problem domain) and
- the synthetic world focus of the **SIMULATION** application (the implementation domain).

The problem domain focus -- made into **REPRESENTATIONS** -- is the content of CMMS. The implementation domain focus -- also made into **REPRESENTATIONS** -- is the content of the related Conceptual Model of the User Space (CMUS) [29]. While the representations place in a CMMS are simulation implementation independent, the choice of which real world activities to **REPRESENT** and the level of detail required in those **REPRESENTATIONS** are strongly influence by simulation implementation dependent **REPRESENTATIONS** placed in a CMUS. The essence of CMMS is the collaboration (usually called knowledge acquisition) between the warfighter and the simulation developer to:

- establish the simulation focus to support a real world purpose,
- select a **REPRESENTATION** (the combination of **MODEL** and **DATA** which determine granularity, inclusion of detail, level of fidelity),
- construct a simulation implementation independent, conceptual description of the real world which specifies the **REPRESENTATION** selected.

Summarizing, CMMS **REPRESENTATIONS** are the bridge in the simulation development sequence between the real world of the warfighter and the synthetic world of the simulation developer, as illustrated

in Figure 1. In particular, CMMS supports critical simulation development (and eventually employment) decisions by

- informing the simulation developer about the warfighter (in order to build and eventually maintain the simulation) and
- informing the warfighter about the simulation (in order to verify, validate, accredit/certify and eventually employ the simulation).

Moreover, CMMS is the well defined interface between warfighter and programmer which enforces a rigorous systems engineering separation of concerns between the real world to be **REPRESENTED** and the simulation world implementation of that **REPRESENTATION**. In particularly, CMMS enables

- the programmer to implement the **REPRESENTATION** without first becoming a professional warfighter.
- the warfighter to employ the **REPRESENTATION** without first becoming a professional programmer.

## 2.3 CMMS Architecture

As shown in Figure 1, CMMS is composed of three primary components:

- conceptual models: consistent **REPRESENTATIONS** of real world military operations,
- technical framework: standards for knowledge creation and integration,
- common repository: DBMS for registration, storage, management, and release.

The notion of developing simulation-independent **REPRESENTATIONS** of the real world to inform the developer before building the simulation is a systems development best-practice which is neither new nor even recent. This notion is variously described as separating:

- "essence from implementation" by Yourdon and Mellor [18]
- "the problem from the machine" by Jackson [19], and
- "requirements from implementation" by MIL-STD-498 [20]

in order to establish "requirements in the vocabulary of the problem domain" as in Booch [21]. The new (or at least recent) notion is to register, integrate, and maintain these representations in a CMMS common repository for eventual access and release for:

- for re-use by subsequent simulation developers,
- verification, validation, and accreditation/certification activities by mission space experts,
- simulation scenario development by end-users, and
- doctrine development by warfighters.

## 3. CMMS Integration and Interoperability Requirements

A fundamental tenet of systems engineering is:

- partition the system into standalone components with well defined interfaces, and
- components interact/affect/communicate only through these defined interfaces.

A corollary to this tenet is that after-the-fact attempts to integrate components which were produced in the absence of before-the-fact interface standards are expensive, error prone, and often unsuccessful. The CMMS-TF defined here employs a **DATA**-centric approach to establish the before-the-fact:

- technical standards ,
- administrative procedures, and
- operational infrastructure

required for after-the-fact conceptual model integration within simulation projects and interoperability across DoD programs. There are many **REPRESENTATION** development methods and an even larger array of software tools and utilities supporting the various methods. The **DATA**-centric approach provides the means to exchange CMMS **REPRESENTATIONS** -- developed using distinct methods and different tools -- using common method-neutral semantics and syntax, standard tool-independent interchange formats, and tool/method-specific style guides.

All requirements defined in the Modeling and Simulation Data Engineering Technical Framework, Version 0.2 are included here by reference. This section extends those general purpose requirements in the DE-TF for the specific purpose of CMMS integration and interoperability requirements as follows:

**COMMON SEMANTICS AND SYNTAX** for **REPRESENTATION** recognition (Section 3.1):

- military operations specific Entities, Actions, Tasks, and Interactions (EATI) and
- information systems specific Operations Specification and Use Case.

CMMS **SYSTEMS ARCHITECTURE** for **REPRESENTATION** realization (Section 3.2):

- MSRR for physical access and network connectivity

CMMS Processes for **REPRESENTATION** repeatability (Section 3.3):

- CMMS implementation of the **DATA PRODUCTION** Sequence
- CMMS implementation of the **DATA** Engineering Process.

CMMS Products for **REPRESENTATION** reuse (Section 3.4):

- CMMS **REGISTRATION** of **AUTHORITATIVE DATA SOURCES** and
- CMMS Operations Specification and Use Case **DATA INTERCHANGE FORMATS**.

## 3.1 Common Semantics and Syntax

**COMMON SEMANTICS AND SYNTAX** for CMMS is subdivided into four components:

- the EATI template for military operations,
- the CMMS Verb Dictionary for action-based abstractions,
- the DDDS Noun Dictionary for entity-based abstractions, and
- the information systems specific **SEMANTICS** and **SYNTAX.**

### 3.1.1 Entities, Actions, Tasks, and Interactions (EATI) Representation

There are a number of satisfactory information-systems-specific **FULLY STRUCTURED VIEWS** [30] for describing, displaying, manipulating, or storing a **REPRESENTATION**. To ensure that the CMMS developer provides sufficient information in the representation to support **CONVERSION** and **INTEGRATION**, this section specifies an entities, actions, tasks, and interactions (EATI) representation to define a **COMMON SYNTAX AND SEMANTICS** template for **REPRESENTATION** content which are independent of an specific **FULLY STRUCTURED VIEW** approach or CASE tool employed to capture it. The EATI representation is a constraint on the form, content, and usage within all **FULLY STRUCTURED VIEWS** for the express purpose of supporting **CONVERSION** and **INTEGRATION**.

**ENTITY**

A distinguishable person, place, thing, or concept about which information is kept [12-13]. In particular, entity includes the notions of **PERSON**, **ORGANIZATION**, **FACILITY**, **FEATURE**, **MATERIEL**, and **PLAN** defined in [25].

Concrete examples of an **ENTITY** include:

- **PERSON** wing commander, pilot
- **ORGANIZATION** Joint Force Air Component Commander (JFACC), flight
- **FACILITY** air base, power plant, pier
- **FEATURE** road, river, bridge
- **MATERIEL** F15, M1A1, missile, radar
- **PLAN** ATO

Abstract examples of an **ENTITY** include:

- GCCS: Core C2 data model entity-relationship diagram
- JWSOL: JTF-ATD object classes

**STATE**

An **ENTITY** attribute representing either an internal condition or an external environment.

**ROLE**

The function provided by, the part played by, or the character assigned to an **ENTITY.**

**EVENT**

**T**he point in time when and the associated location in space where a change in **STATE** or condition occurs.

**VERB**

The alteration or transformation by natural force or human agency which produces an **EVENT**.

Concrete examples of a **VERB** include:

- physical verbs: move, sense, communicate, engage, replenish
- cognitive verbs: develop, monitor, analyze, supervise

**ACTION**

**VERB** + **ENTITY** defining a **ROLE** or capability.

Concrete examples of an **ACTION** include:

- refuel aircraft
- launch missile
- detect submarine
- generate ATO

Abstract examples of an **ACTION** include:

- UJTL: process-oriented operations templates

- CMMS Verb Syntax: behavior-oriented C2 templates

**ACTOR**

The **ENTITY** which takes, executes, conducts, or controls a particular **ACTION**.

**ENTRANCE CRITERIA**

The set of **STATES** and the sequence of **EVENTS** which are necessary and sufficient to initiate, begin, restart, or continue an **ACTION** by an **ACTOR**.

**EXIT CRITERIA**

The set of **STATES** and the sequence of **EVENTS** which are necessary and sufficient to terminate, interrupt, end, or conclude an **ACTION** by an **ACTOR**.

**TASK**

The execution of one or more **ACTIONS** by an **ACTOR**. task is the smallest unit of unambiguous operational meaning. The **ACTOR** initiates execution when specific **ENTRANCE CRITERIA** are met. During execution the **TASK** may receive or consume one or more inputs, may produce or deliver to one or more outputs, and may change one or more internal **STATES**. Execution continues until specific **EXIT CRITERIA** are satisfied.

Concrete examples of a **TASK** include:

- **ACTOR** **ACTION (VERB + ENTITY)**
- KC135 refuels F15
- F15 launches AIM-9L
- JFACC generates ATO

Abstract examples of a **TASK** include:

- linguistics: subject + verb + object = a sentence
- mathematics: domain + mapping + range = a function

**INTERACTION**

The interface which defines the flow of **EVENTS**, **STATE**, **ENTITIES**, **ACTIONS**, or **TASKS** between **ENTITIES**, **ACTIONS**, or **TASKS**.

**MISSION**

A **TASK** which is executed by an **ACTOR** to achieve a specific **OBJECTIVE**. A **MISSION** includes the specific **ENTRANCE CRITERIA** and **EXIT CRITERIA** which govern its initiation and termination as well as the specific measures of performance and effectiveness which indicate its relative success.

**MISSION SPACE**

A set of **MISSIONS** which share a common organizing principle, purpose, or feature.

Note: each EATI component can be recursively decomposed into one more EATI components.

Minimum Requirement:

Each **REPRESENTATION REGISTERED** in CMMS shall comply with the CMMS EATI **COMMON SEMANTICS AND SYNTAX**.

Each **REPRESENTATION REGISTERED** in CMMS shall provide a dictionary of all **ENTITIES**, **ACTIONS**, **EVENTS**, **TASKS**, and **INTERACTIONS** employed by that **REPRESENTATION**.

Non-standard **SEMANTIC** and **SYNTAX** shall be documented in an on-line dictionary system and are mapped to the standard EATI **SEMANTICS** and **SYNTAX**.

Preferred Practice:

**REPRESENTATIONS** registered in CMMS should employ standard **ENTITIES**, **ACTIONS**, **EVENTS**, **TASKS**, and **INTERACTIONS** from the DoD Data Dictionary System, the Universal Joint Task List (or associated JMETL, Service METL, or Service TTL), and the CMMS Verb Dictionary [31].

### 3.1.2 CMMS Verb Dictionary for Action-Based Abstractions

[TBD]

### 3.1.3 DDDS Noun Dictionary for Entity-Based Abstractions

[TBD]

### 3.1.4 Information Systems Specific Semantic and Syntax

[TBD]

## 3.2 Systems Architecture for CMMS

Minimum Requirement:

The CMMS common repository shall be MSRR compliant.

The CMMS data interchange format shall support Operations Specification and Use-Case templates.

## 3.3 CMMS Processes

### 3.3.1 Data Production Sequence for CMMS

The CMMS adaptation of the **DATA PRODUCTION SEQUENCE** in Figure 2 is the high-level structure for

- identifying components of the common technical approach,
- synchronizing development schedules and correlating technical content, and
- identifying critical integration and interoperability points

in the development and delivery of a particular set of CMMS representations. The adaptation of the general purpose development steps in the DE-TF to the specific requirements of CMMS are as follows:

- **DEVELOP FOCUSED CONTEXT** to provide concrete operational conditions and establish knowledge acquisition priorities with agreed upon campaign partitions with correlated interactions,

- **GATHER INFORMATION** using coordinated literature searches and site-visits executed on a synchronized development schedule/timeline,
- **FORMALIZE INPUT RESOURCES** using operation-specification and use-case templates with EATI nomenclature, CMMS Verb Dictionary and DDDS data elements, and UJTL tasks.
- **CONSTRUCT** CMMS **RESOURCES** using both entity-based abstractions and action-based abstractions to build **REPRESENTATIONS** to describe the mission space.

Interface Design Descriptions (IDD's) based on

- method-neutral common semantics and syntax
- tool-independent data interchange formats
- tool-specific style guides, and
- Modeling and Simulation Resource Repository (MSRR) compliant physical access and network connectivity

provide the formal CMMS-TF integration procedures and interoperability standards to support

- **REPRESENTATION** integration between distinct projects within a specific CMMS development step, and
- **REPRESENTATION** exchange between distinct CMMS development steps with a specific project.

As an example, consider one pass through the four-step CMMS development sequence (shown if Figure 2) to create a Close Air Support (CAS) **REPRESENTATION** by a hypothetical Air Development Agent (Air DA) and Land Development Agent (Land DA):

**DEVELOP FOCUSED CONTEXT**, the Air DA and Land DA meet to develop a focused context to size and bound the CAS **REPRESENTATION** to be created. A mission thread or operational scenario (see for example [25]) is created to size and bound the mission space problem to be **REPRESENTED** and to provide a realistic sample of real world to be synthesized. An end-use thread or simulation scenario is created to describe a priori constraints on the simulation arising from intended use or simulation implementation choices made during a prior development spiral (such as the NASM Conceptual Model of the User Space (CMUS) or the WarSim Task Requirements Analysis Process (TRAP)). The combination of mission space and user space thread information defines the focused context for defining the **REPRESENTATION** of interest. This focused context establishes synchronized campaign partitions and identifies correlated interactions for use by both Air DA and Land DA **REPRESENTATION** developers. The Air DA and Land DA register the description of the focused context (likely computer-readable compound documents with embedded figures) on the MSRR. MSRR provides access to the focused context to individuals with an appropriate need to know (and security clearance if classified materials are involved) based on releasability policies established by the appropriate authorities.

**GATHER INFORMATION**, the Air DA and Land DA employ the focused context to

- determine the scope and establish the priority for specific **INFORMATION** gathering activities to support the CAS **REPRESENTATION**,
- use the agreed upon mission partitions (within each mission thread of interest) to synchronize activities by each organization on an agreed-upon timeline/schedule so that the various development groups are working their respective portions of a particular mission partitions concurrently.
- assign a lead organization for gathering each type of **INFORMATION** (or for gathering information by a particular means) required by the **REPRESENTATION**.

The assigned leads within the Air DA and Land DA then

- identify appropriate authoritative data sources
- coordinate site visits and interviews so that multiple **INFORMATION** gathering organizations can participate in a single joint meeting with a specific set of mission space SME's whenever practical.
- share and disseminate gathered **INFORMATION** for the desired **REPRESENTATION**, both literature and SME interaction summaries, through MSRR/CMSRR registration, release, and configuration management.

**FORMALIZE INPUT RESOURCES**, prior to the construction of a formal conceptual **MODEL** in the form of a **REPRESENTATION**, the mass of information gathered is organized into structured text descriptions with supporting diagrams. To facilitate subsequent data integration and model interoperability, the Air DA and Land DA each formalize their respective mission space **DATA**:

- using common capture and collection templates to structure the **INFORMATION** and
- using **COMMON SEMANTICS AND SYNTAX** to describe the template entries.

In particular the DA's employ templates which:

- organize static **INFORMATION** using **DATA** elements derived from UML-style op-specs, and
- organize dynamic **INFORMATION** using **DATA** elements derived from UML-style use cases.

For the template entries, the DA's employ the DMSO sponsored CSS to tag the original text/diagrams:

- entity/noun-based taxonomies and naming conventions taken from existing sources, such as the DoD Enterprise Data Model, the DoD Data Dictionary System, or the Joint Warfare Simulation Object Model and
- action/verb-based taxonomies and naming conventions will be take from existing sources, such as the Universal Joint Task List or the DMSO sponsored CMMS Verb Dictionary.

The Air and Land DA's register, convert, integrate, release, and manage the organized **DATA** for the desired **REPRESENTATION**, both op-spec's and use cases, via the MSRR/CMSRR compliant CMMS common repository.

**CONSTRUCT** CMMS **RESOURCES**: In the desired CAS **REPRESENTATION**, the stable (and therefore central) organizing principles are action-based abstractions, that is the processes, missions, tasks, and actions. However, the Air and Land DA's have agreed to implement the desired CAS simulation using an object-oriented paradigm. In the desired OO simulation implementation, the stable (and therefore central) organizing principles are entity-based abstractions. The development of balanced conceptual models which provide both entity-based and action-based abstractions are an essential precursor to subsequent object-oriented analysis. Therefore, as a precursor to object-oriented analysis, the Air DA and Land DA each construct balanced entity and action based conceptual **MODELS** using the intrinsically process-oriented CAS **REPRESENTATION** obtained from military operations doctrine and SME's. To ensure that their separately constructed CAS **MODELS** can be subsequently converted and integrated, the DA's employ the CMMS Technical Framework standards for

- a method-neutral CSS,
- a tool-independent Data Interchange Formats (DIF), and

- tool specific style-guides for incorporating CSS content into a DIF compatible structure

as formal Interface Design Descriptions. Finally, the Air and Land DA's register, convert, integrate, release, and manage these conceptual **MODELS** for the desired CAS **REPRESENTATION** via the MSRR/CMSRR compliant CMMS common repository.

Minimum Requirement:

**REPRESENTATIONS REGISTERED** in CMMS shall be constructed using the **DATA PRODUCTION** Sequence for CMMS.

### 3.3.2 Data Engineering Process for CMMS

Minimum Requirement:

**REPRESENTATIONS REGISTERED** in CMMS be developed and maintained in accordance with the DE-TF **DATA ENGINEERING PROCESS.**

## 3.4 Data Product Technical Architecture for CMMS

### 3.4.1 Authoritative Data Sources for CMMS

Minimum Requirement:

**REPRESENTATIONS** shall be **REGISTERED** in CMMS in accordance with the DE-TF **AUTHORITATIVE DATA SOURCES** requirements.

### 3.4.2 Data Interchange Formats for CMMS

[TBD]

### 3.4.3 Authorized Data Consumers for CMMS

Minimum Requirement:

**REPRESENTATIONS REGISTERED** in CMMS shall be **RELEASED** in accordance with the DE-TF **AUTHORIZED DATA CONSUMER** requirements.

- CMMS **REGISTRATION** of **AUTHORITATIVE DATA SOURCES** and
- CMMS Operations Specification and Use Case **DATA INTERCHANGE FORMATS.**

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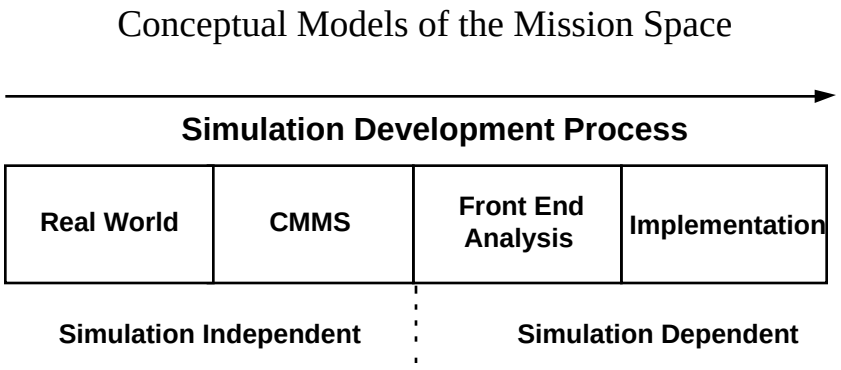
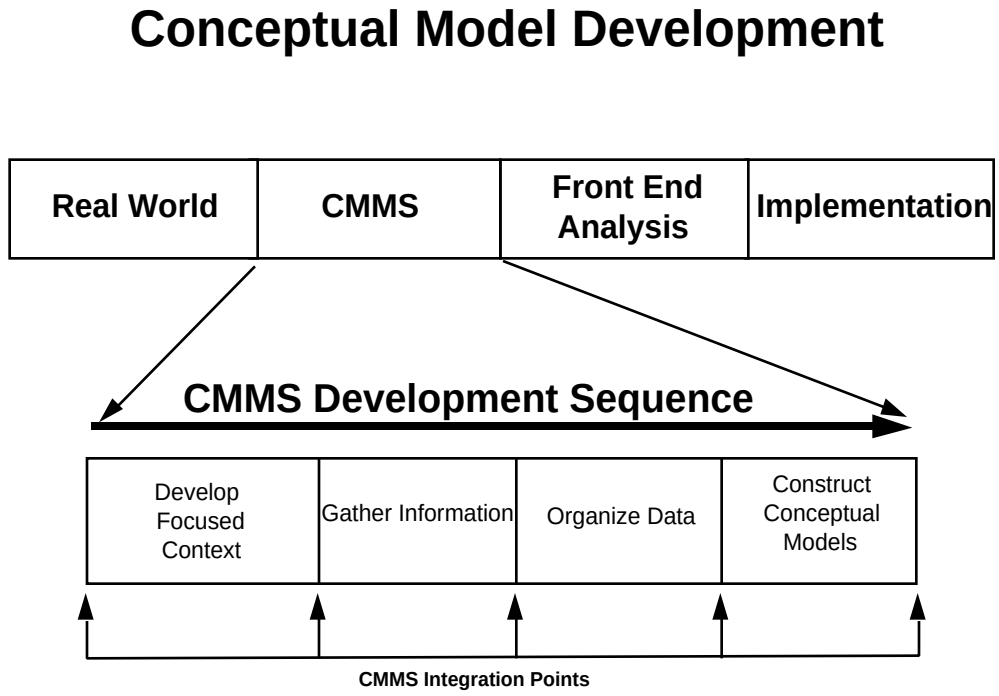
## 5. Figures




Three main thrusts for the DoD CMMS Project

- Conceptual Models: consistent representations of real world military operations
- Technical Framework: standards for knowledge capture and integration
- Common Repository: DBMS for management and release

Figure 1




**Common Semantics and Syntax (CSS)**

- **defines logical content and structure**
- **entities, actions, tasks, & interactions**
- **KA method-neutral**

**Data Interchange Formats (DIF)**

- **defines physical realization**
- **standard format for interchange**
- **CASE-tool independent**

Figure 2

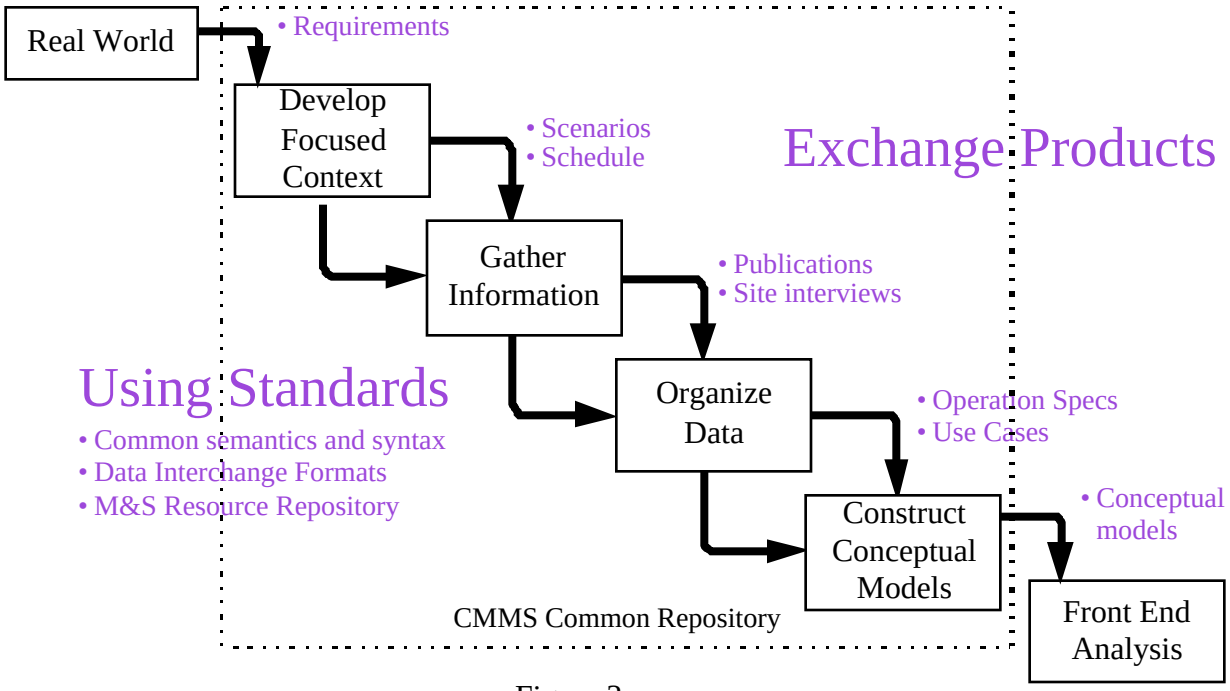



Figure 3

## 6. Tables

[TBD]

## 7. Specifications Compendium

## 7.1. Terminology

CMMS Technical Framework specifications are captioned:

- Minimum Requirement: mandatory specification considered necessary (but not necessarily sufficient) for CMMS interoperability and re-use.
- Preferred Practice: best practices specification considered sufficient for CMMS interoperability and re-use.
- Technology Extension: optional specification which in not considered mandatory for CMMS interoperability and re-use but which is considered indicative of the technology adoption trend.

## 7.2. Minimum Requirements

1. All Minimum Requirements defined in the Modeling and Simulation Data Engineering Technical Framework, Version 0.2 are included here by reference.

2. Each **REPRESENTATION REGISTERED** in CMMS shall comply with the CMMS EATI **COMMON SEMANTICS AND SYNTAX.**

3. Each **REPRESENTATION REGISTERED** in CMMS shall provide a dictionary of all **ENTITIES**, **ACTIONS**, **EVENTS**, **TASKS**, and **INTERACTIONS** employed by that **REPRESENTATION.**

4. Non-standard **SEMANTIC** and **SYNTAX** shall be documented in an on-line dictionary system and are mapped to the standard EATI **SEMANTICS** and **SYNTAX.**

5. The CMMS common repository shall be MSRR compliant.

6. The CMMS **DATA INTERCHANGE FORMAT** shall support Operations Specification and Use-Case templates.

7. **REPRESENTATIONS REGISTERED** in CMMS shall be constructed using the **DATA PRODUCTION** Sequence for CMMS.

8. representations shall be registered in CMMS in accordance with the M&S DSA authoritative data sources requirements.

9. **REPRESENTATIONS** should be **CONVERTED , INTEGRATED,** and interchanged using the CMMS Operations Specification and Use Case **DATA INTERCHANGE FORMATS.**

## 3. Preferred Practices

1. All Preferred Practices defined in the Modeling and Simulation Data Engineering Technical Framework, Version 0.2 are included here by reference.

2. **REPRESENTATIONS** registered in CMMS should employ standard **ENTITIES**, **ACTIONS**, **EVENTS**, **TASKS**, and **INTERACTIONS** from the DoD Data Dictionary System, the Universal Joint Task List (or associated JMETL, Service METL, or Service TTL), and the CMMS Verb Dictionary.

3. **REPRESENTATIONS REGISTERED** in CMMS shall be **RELEASED** in accordance with the M&S DSA **AUTHORIZED DATA CONSUMER** requirements.

## 4. Technology Extensions

1 All Preferred Practices defined in the Modeling and Simulation Data Engineering Technical Framework, Version 0.2 are included here by reference.

## Enclosures

[TBD]

## Annexes

[TBD]